

PATENT ABSTRACTS OF JAPAN

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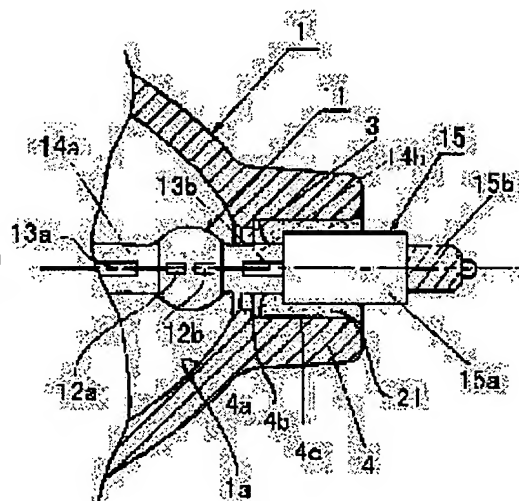
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(54) SHORT ARC DISCHARGE LAMP WITH REFLECTING MIRROR

(57)Abstract:

PROBLEM TO BE SOLVED: To satisfy the smaller size of the device and the higher efficiency of its optical characteristics required as the light source device for a liquid crystal projector of a mobile system.

SOLUTION: The short arc discharge lamp 11 with the reflecting mirror 1 consists of the reflecting mirror 1 made of glass which has a reflection surface consisting of an even order function on its inside surface and is formed by die pressing and the short arc discharge lamp 11 which is internally sealed with a pair of electrodes 12a and 12b, is formed with sealing parts 14a and 14b at both ends and is fixed with a mouthpiece 15 in the one sealing part 14b. The short arc discharge lamp 11 is arranged to be aligned with the optical axis of the reflecting mirror 1 and the mouthpiece is fixed into the slot of a hollow neck part 4 formed at the center in the bottom of the reflecting mirror 1. The peripheral part of the mouthpiece on the inside surface of the slot 3 of the hollow neck part is worked to a cylindrical shape and a narrowest part 4b is formed toward the reflection surface from the cylindrical part 15a. A die pressing part 4a is formed toward the reflection from the narrowest part 4b so that the die pressing part 4a comes into contact with the reflection surface while flaring.



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CLAIMS

[Claim(s)]

[Claim 1] The reflecting mirror made from glass which has the reflector which turns into an inside from a **** function and which carries out die pressing and it comes to fabricate, The short arc discharge lamp which sealed the electrode of a pair inside, formed the closure section in the both ends, and fixed the mouthpiece to one closure section, In the short arc discharge lamp with a reflecting mirror which comes to fix said mouthpiece to the insertion hole of the hollow necklike part which has arranged said discharge lamp so that it may be in agreement with the optical axis of said reflecting mirror, and was formed in the center of a pars basilaris ossis occipitalis of said reflecting mirror Process a periphery in the shape of a cylinder, and it forms the narrowest part toward a reflector from this cylindrical section. the mouthpiece of the inside of the insertion hole of said hollow necklike part -- The short arc discharge lamp with a reflecting mirror which carries out die pressing toward a reflector from this narrowest part, and is characterized by the section, nothing, and this thing formed so that die pressing may be carried out and the section may touch a reflector with breadth.

[Claim 2] The short arc discharge lamp with a reflecting mirror given in claim 1 term which the outflow of adhesives is prevented by said narrowest part, and carries out die pressing and is characterized by said thing [fixing a mouthpiece to the insertion hole of a necklike part, as adhesives do not flow into the section] in case the mouthpiece of said discharge lamp is inserted in the cylindrical section formed in the insertion hole of the hollow necklike part of said reflecting mirror free [justification] and adhesives are poured into the insertion hole of said necklike part.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to amelioration of the reflecting mirror made from glass especially about the light equipment used as a back light of liquid crystal projection equipment.

[0002]

[Description of the Prior Art] In recent years, a short arc discharge lamp is spreading quickly as the light source for liquid crystal projectors. This kind of lamp is used as light equipment combined with the reflecting mirror in which the reflector which turns into that inside from paraboloid of revolution or an ellipsoid of revolution was formed so that light may condense to a liquid crystal panel. Furthermore, as light equipment for projectors of a mobile system, a miniaturization and efficient-ization are called for more and the various proposals for using effectively miniaturization of light equipment and the reflector of a reflecting mirror are made.

[0003] As one, the unit of an electric bulb as shown in JP,6-203806,A, and a reflector is indicated. As shown in drawing 5 from drawing 3, the reflector 31 forms the hollow necklike part 32 in the pars basilaris ossis occipitalis in the case of reflecting mirror processing made from glass, but in order to make the electric bulb insertion hole 33 small and to form reflector 31a greatly, die pressing of this is carried out and it is carrying out post processing for using a rotation grinding stone etc. and forming the electric bulb insertion hole 33 after shaping (drawing 3), (drawing 4). Therefore, since the front face of the electric bulb insertion hole which is the end face of this hollow necklike part has got damaged with the grinding stone when using it as a unit, the problem that a crack will enter with the heat under electric bulb lighting, and it will be divided arises. Moreover, when a hollow necklike part is filled up with the adhesives for electric bulb fixing (cement), there is a problem of being further easy to be divided with the thermal stress by the difference of the coefficient of thermal expansion of glass and adhesives.

[0004] Moreover, as shown in drawing 5, a reflector 31 and an electric bulb 41 are arranged so that the medial axis of a reflector and the optical axis of an electric bulb may be in agreement, and the interior of the hollow necklike part 32 is filled up with adhesives 51, it fixes to it, and a unit is assembled. however, with [which is fixed to the seal section 42 of an electric bulb 41 in the case of an assembly] a screw -- since the mouthpiece 43 is arranged at taper-like section 32a of the inside of said hollow necklike part 32, when dispersion has arisen in the electrode location sealed in the medial axis of an electric bulb at the time of electric bulb manufacture, there is a problem from which a justification activity with an electric bulb and a reflector is difficult, and serves as a defective.

[0005] As this cure, at the time of adjustment of the optical axis of an electric bulb and a reflector, it is made for body 43a of a mouthpiece 43 not to contact narrow part 32b by the side of reflector 31a of taper-like section 32a of the hollow necklike part 32, and the mouthpiece 43 is estranged greatly and fixed after that using adhesives 51 from reflector 31a of a reflector 31. In addition, 52 in drawing is a glass member for ring-like prevention [adhesives outflow]. However, even if it uses adhesives after justification in this way and fixes an electric bulb 41, when it is going to stop the lug terminal for electric power supplies using screw 43b formed in the edge of body 43a of a mouthpiece, since the mouthpiece is not being fixed to the necklike part of a shallow reflector, the seal section of an electric bulb has the fault that only a mouthpiece will be turned and damaged while it had been fixed to adhesives by it.

[0006]

[Problem(s) to be Solved by the Invention] This invention is made in view of the above, and can satisfy the miniaturization of the equipment demanded as light equipment for liquid crystal projectors of a mobile system, and the increase in efficiency of an optical property. And even if it prevents the crack from the end face of the necklike part of the reflecting mirror by generation of heat from the discharge lamp accompanying a miniaturization and gap from the medial axis of an electrode shaft arises at the time of lamp manufacture, justification with a reflecting mirror and a lamp

is possible, and it is long lasting, and aims at offering the short arc discharge lamp with a reflecting mirror excellent in the optical property.

[0007]

[Means for Solving the Problem] In order to attain said purpose, the short arc discharge lamp with a reflecting mirror concerning this invention The reflecting mirror made from glass which has the reflector which turns into an inside from a **** function and which carries out die pressing and it comes to fabricate, The short arc discharge lamp which sealed the electrode of a pair inside, formed the closure section in the both ends, and fixed the mouthpiece to one closure section, It comes to fix said mouthpiece to the insertion hole of the hollow necklike part which has arranged said discharge lamp so that it may be in agreement with the optical axis of said reflecting mirror, and was formed in the center of a pars basilaris ossis occipitalis of said reflecting mirror. the mouthpiece of the inside of the insertion hole of said hollow necklike part -- a periphery processes the shape of a cylinder, the narrowest part is formed toward a reflector from this cylindrical section, die pressing is carried out toward a reflector from this narrowest part, and it is characterized by the section, nothing, and forming so that this die pressing may be carried out and the section may touch a reflector with breadth.

[0008]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained based on a drawing. Drawing 1 and drawing 2 are the sectional views and important section expanded sectional views showing the short arc discharge lamp with a reflecting mirror concerning the example of this invention. One in drawing is the reflecting mirror made from hard glass (expansion coefficient 38×10^{-7} cm/**) which formed paraboloid-of-revolution-like reflector 1a in the inside, opening 2 is formed in one side of this reflecting mirror, and the necklike part 4 which has the insertion hole 3 is formed in the center of a pars-basilaris-ossis-occipitalis side of another side. 11 in drawing is a short arc discharge lamp which consists of an arc tube made from a quartz, the electrodes 12a and 12b of a pair are sealed in accordance with an optical axis inside, and photogene, such as mercury, is enclosed with starting gas. Moreover, the arc tube closure sections 14a and 14b which laid the molybdenum foils 13a and 13b underground are formed in the both ends of a light-emitting part. moreover -- one closure section 14b -- with a screw -- the mouthpiece 15 is being fixed and the mouth piece 15 consists of body 15a and screw section 15b of the edge.

[0009] with [which was fixed to the insertion hole 3 which as for the reflecting mirror 1 and discharge lamp 11 whose aforementioned focal distance is 6mm it has been arranged so that the medial axis of a reflecting mirror and the optical axis of a lamp may be in agreement, and was formed in the necklike part 4 of a reflecting mirror 1 at arc tube closure section 14b of a discharge lamp 11] a screw -- a mouthpiece 15 is inserted and it is fixing using adhesives 21.

[0010] Mold push section 4a in which the part (inlet-port section of an insertion hole) in which the inside of the necklike part 4 of the reflecting mirror 1 concerning this invention follows the insertion hole 3 of a necklike part 4 from reflector 1a spread a little toward the pars basilaris ossis occipitalis is formed. Since this has considered the mold push side in the metal mold at the time of manufacturing the reflecting mirror made from glass which carried out press forming as as [ground] and shaving processing is not needed, there is no blemish and it completely serves as a smooth front face. Furthermore, in case narrowest partial 4b of the insertion hole 3 is formed in said part which carries out die pressing and follows section 4a and the adhesives 21 after an assembly are poured in, die pressing is carried out and it is made for adhesives to have not flowed into section 4a.

[0011] Moreover, the part ranging from narrowest partial 4b to the heel of the insertion hole 3 is formed in cylindrical 4c. with [which was fixed to arc tube closure section 14b which inserts this in the insertion hole 3 of a necklike part 4] a screw -- body 15a of a mouthpiece 15 can fully insert, and to the axial knee of the electrode of the pair which may be produced at the time of lamp manufacture, justification which makes the medial axis of a reflecting mirror agree is made into the shape of a cylindrical shape used as a big path so that it may be possible enough. In addition, in order to consider as the structure which is hard to have after fixing, the configuration of the body of the mouthpiece inserted in the insertion hole 3 has the same effectiveness, also case [whose cross-section configuration is / like a hexagon].

[0012] By said configuration, in order to attain miniaturization of light equipment, even if the ambient temperature of the light equipment used inside a liquid crystal projector is set up highly, a crack does not occur from the glass processing section of the necklike part inside of a reflecting mirror like before, and a life property is improved. for example, the case of the equipment used in a horizontal position -- the part of a reflecting mirror which serves as an elevated temperature most -- the part of H of drawing 1 -- it is -- the conventional example -- about 480-degree-C order -- becoming -- the distortion temperature of glass -- 520 degrees C -- it is also -- it does not start, but if lighting is repeated, a crack will be carried out from the circumference of the part deleted and processed. Since a necklike part carries out die pressing of the reflecting mirror applied to this invention on the other hand, it does not have the part deleted and processed into the section and this part does not serve as the elevated-temperature section, even if it uses the

glass of the same presentation and becomes the temperature around 500 degrees C at the time of lighting, a crack does not arise during a lamp life period.

[0013] Moreover, silica alumina is fixed after justifying a reflecting mirror and a lamp using a principal component and adhesives. Although adhesives 21 are poured in from the notching section prepared in the pars basilaris ossis occipitalis of the necklike part 4 of the reflecting mirror which is the inlet of adhesives, generating of the crack by the stress which adhesives carry out die pressing, does not flow into section 4a and reflector 1a, and is produced by the differential thermal expansion of the reflecting mirror made from glass and adhesives since it has prevented that adhesives flow out by narrowest part 4b can also be prevented.

[0014]

[Effect of the Invention] As explained above, the short arc discharge lamp with a reflecting mirror concerning this invention improves the structure of the necklike part of the pars basilaris ossis occipitalis of a reflecting mirror, and a configuration, and the field close to the light-emitting part of the lamp which is a source of generation of heat does not process it by deleting. for this reason, the end face of the lamp insertion hole which touches a reflector -- die pressing -- carrying out -- as [field] -- carrying out -- and with [of a lamp] a screw -- the perimeter section of the insertion hole surrounding a mouthpiece is taken as the body of a mouthpiece, and the cylindrical section of isomorphism. And even if dispersion on manufacture of a lamp has produced optical-axis adjustment with a reflecting mirror and a lamp by fully enlarging a path, it can fully carry out. Furthermore, by preparing the narrowest part which carries out die pressing to the cylindrical section of an insertion hole, and serves as a batch between the sections, even if adhesives do not flow during an activity at a reflector side and it becomes an elevated temperature into a lamp life, the short arc discharge lamp with a reflecting mirror in which a crack did not occur and optical effectiveness was excellent is obtained.

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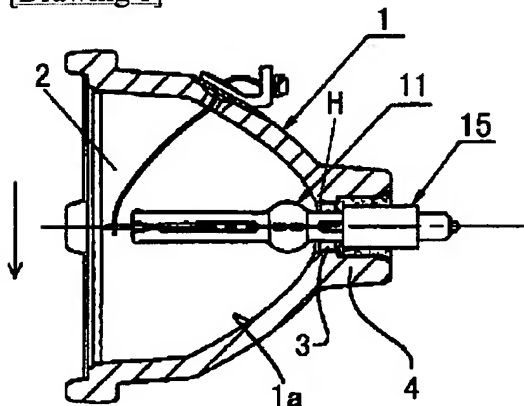
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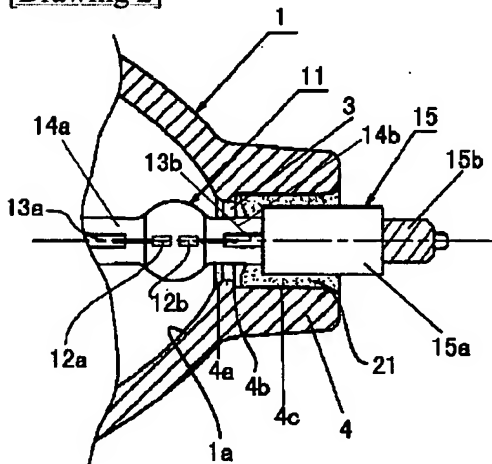
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DRAWINGS

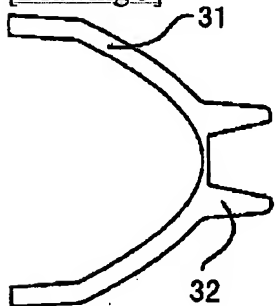
[Drawing 1]



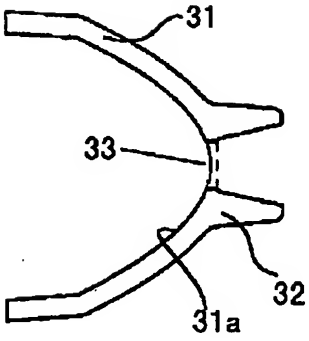
[Drawing 2]



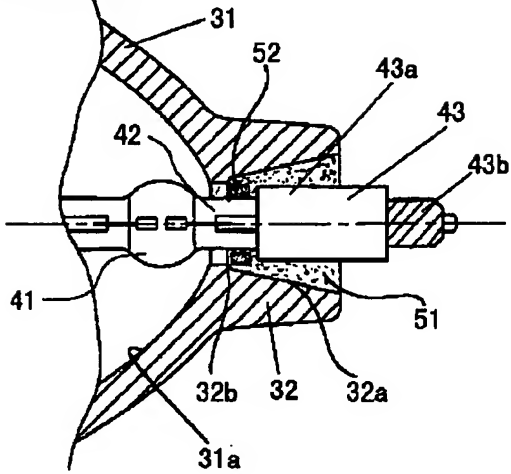
[Drawing 3]



[Drawing 4]



[Drawing 5]



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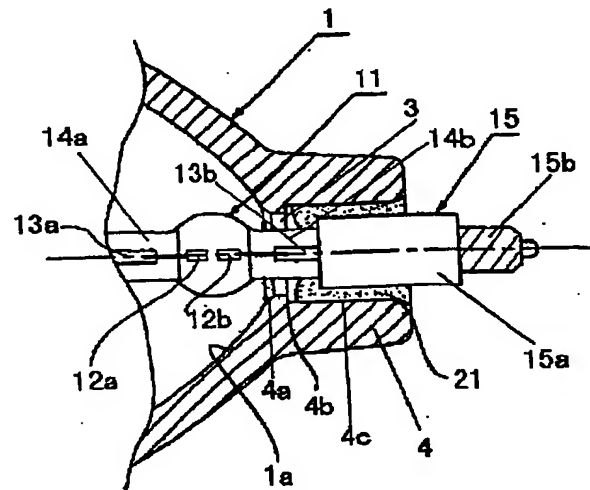
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(54)【発明の名称】 反射鏡付きショートアーク放電ランプ

(57)【要約】 (修正有)

【課題】 モバイル系の液晶プロジェクタ用光源装置として要求される装置の小型化及び光学的特性の効率化を満足させる。

【解決手段】 反射鏡付きショートアーク放電ランプ1は内面に偶次関数からなる反射面を有する型押し成形してなる硝子製反射鏡1と、内部に一对の電極12a、12bを封着し両端に封止部14a、14bを形成し、一方の封止部14bに口金15を固定したショートアーク放電ランプ11と、前記反射鏡1の光軸に一致するように前記放電ランプ11を配置し、前記反射鏡1の底部中央に形成した中空首状部4の挿通孔に前記口金を固定してなり、前記中空首状部の挿通孔3の内面の口金周辺部は、円筒状に加工し、該円筒部15aより反射面に向かって最狭部4bを形成し、該最狭部4bより反射面に向かって型押し部4aとなし、該型押し部4aが広がりながら反射面に接するように形成することを特徴とする。



(2)

【特許請求の範囲】

【請求項1】 内面に偶次関数からなる反射面を有する型押し成形してなる硝子製反射鏡と、内部に一对の電極を封着しその両端に封止部を形成し、一方の封止部に口金を固定したショートアーク放電ランプと、前記反射鏡の光軸に一致するように前記放電ランプを配置し、前記反射鏡の底部中央に形成した中空首状部の挿通孔に前記口金を固定してなる反射鏡付きのショートアーク放電ランプにおいて、前記中空首状部の挿通孔の内面の口金周辺部は円筒状に加工し、該円筒状部より反射面に向かって最狭部を形成し、該最狭部より反射面に向かって型押し部となし、該型押し部が広がりながら反射面に接するように形成することを特徴とする反射鏡付きショートアーク放電ランプ。

【請求項2】 前記反射鏡の中空首状部の挿通孔に形成した円筒状部に前記放電ランプの口金を位置調整自在に挿入し、前記首状部の挿通孔に接着剤を注入する際に、前記最狭部により接着剤の流出が阻止され、前記型押し部に接着剤が流入しないようにして首状部の挿通孔に口金を固定することを特徴とする請求項1項記載の反射鏡付きショートアーク放電ランプ。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】 本発明は液晶プロジェクション装置のバックライトとして用いられる光源装置に関し、特に硝子製反射鏡の改良に関する。

【0002】

【従来の技術】 近年、液晶プロジェクタ用光源としてショートアーク放電ランプが急速に普及しつつある。この種のランプは、液晶パネルに光が集光するように、その内面に回転放物面あるいは回転楕円面よりなる反射面を形成した反射鏡と組み合わせた光源装置として用いられている。更に、モバイル系のプロジェクタ用光源装置として、より小型化及び高効率化が求められており、光源装置のコンパクト化及び反射鏡の反射面を有効に利用するための種々の提案がなされている。

【0003】 一つとして、特開平6-203806号公報に示すような電球および反射器のユニットが開示されている。これは、図3から図5に示すように硝子製反射鏡加工の際、反射器31はその底部に中空首状部32を形成しているが、電球挿入孔33を小さくしかつ反射面31aを大きく形成するために、型押し成形後(図3)に、回転砥石等を用いて電球挿入孔33を形成するための後加工をしている(図4)。そのため、ユニットとして使用する場合、該中空首状部の端面である電球挿入孔の表面が砥石により傷ついているために、電球点灯中の熱によりクラックが入り割れてしまうという問題が生じる。また、中空首状部に電球固着用接着剤(セメント)を充填すると、硝子と接着剤との熱膨張率の差による熱応力によって、さらに割れやすいという問題がある。

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【0004】 また、図5に示すように、反射器31と電球41とを反射器の中心軸と電球の光軸とが一致するように配置し、中空首状部32の内部に接着剤51を充填して固定し、ユニットを組み立てる。しかし、組立ての際、電球41のシール部42に固定するネジ付き口金43が前記中空首状部32の内面のテーパ状部32aに配置されているため、電球製造の際電球の中心軸に封着した電極位置にばらつきが生じていると、電球と反射器との位置調整作業が困難で、不良品となる問題がある。

【0005】 この対策として、電球と反射器との光軸の調整時に、中空首状部32のテーパ状部32aの反射面31a側の狭部32bに口金43の円筒部43aが接触しないようにし、反射器31の反射面31aより口金43が大きく離間するようにしてあり、その後、接着剤51を用いて固定される。なお、図中52はリング状の接着剤流出防止用のガラス部材である。しかし、このように位置調整後に接着剤を用いて電球41を固着しても、口金の円筒部43aの端部に形成したネジ43bを利用して、電力供給用ラグ端子を止めようとすると、口金43が浅くしか反射器の首状部に固定されていないため電球のシール部は接着剤に固定されたまま、口金だけが回ってしまい破損してしまうという欠点がある。

【0006】

【発明が解決しようとする課題】 本発明は、前記に鑑みてなされたものであり、モバイル系の液晶プロジェクタ用光源装置として要求される装置の小型化及び光学的特性の効率化を満足させることができる。そして、小型化に伴う放電ランプからの発熱による反射鏡の首状部の端面からのクラックを防止し、かつ、ランプ製造時に電極軸の中心軸からのズレが生じても反射鏡とランプとの位置調整が可能であり、長寿命で光学特性が優れた反射鏡付きショートアーク放電ランプを提供することを目的とする。

【0007】

【課題を解決するための手段】 前記目的を達成するため、本発明に係る反射鏡付きショートアーク放電ランプは、内面に偶次関数からなる反射面を有する型押し成形してなる硝子製反射鏡と、内部に一对の電極を封着しその両端に封止部を形成し、一方の封止部に口金を固定したショートアーク放電ランプと、前記反射鏡の光軸に一致するように前記放電ランプを配置し、前記反射鏡の底部中央に形成した中空首状部の挿通孔に前記口金を固定してなり、前記中空首状部の挿通孔の内面の口金周辺部は円筒状に加工し、該円筒状部より反射面に向かって最狭部を形成し、該最狭部より反射面に向かって型押し部となし、該型押し部が広がりながら反射面に接するように形成することを特徴とする。

【0008】

【発明の実施の形態】 以下、本発明の実施の形態を図面にに基づき説明する。図1及び図2は、本発明の実施例に

(3)

係る反射鏡付きショートアーク放電ランプを示す断面図及び要部拡大断面図である。図中1は内面に回転放物面状反射面1aを形成した硬質硝子製(膨張率 $3.8 \times 10^{-7} \text{ cm}/^\circ\text{C}$)の反射鏡であり、該反射鏡の一方には開口部2が形成され、他方の底部側中央には挿通孔3を有する首状部4が形成されている。図中11は石英製発光管よりなるショートアーク放電ランプであり、内部に一对の電極12a、12bを光軸に沿って封着し、始動ガスと共に水銀等の発光物質が封入されている。また、発光部の両端にはモリブデン箔13a、13bを埋設した発光管封止部14a、14bが形成されている。また、一方の封止部14bにはネジ付き口金15が固定されており、該口金15は円筒部15aとその端部のネジ部15bとからなる。

【0009】前記の焦点距離が6mmの反射鏡1と放電ランプ11とは、反射鏡の中心軸とランプの光軸が一致するように配置され、反射鏡1の首状部4に形成した挿通孔3に、放電ランプ11の発光管封止部14bに固定したネジ付き口金15を挿入し、接着剤21を用いて固定している。

【0010】本発明に係る反射鏡1の首状部4の内面は、反射面1aから首状部4の挿通孔3に連続する部分(挿通孔の入口部)は、底部に向かって若干広がった型押し部4aが形成されている。これは、硝子製反射鏡を製造する際の、金型でのプレス成形した型押し面を生地のままとしてあり、削り加工を必要としないので、全く傷はなく滑らかな表面となっている。更に、前記型押し部4aに連続する部分に挿通孔3の最も狭い部分4bが形成されており、組立ての後の接着剤21を注入する際に、型押し部4aに接着剤が流出しないようにしてある。

【0011】又、挿通孔3の最も狭い部分4bからその外端部にわたる部分は円筒状4cに形成されている。これは、首状部4の挿通孔3に挿入する発光管封止部14bに固定したネジ付き口金15の円筒部15aが十分に挿入可能であり、ランプ製造時に生じることがある一对の電極の軸曲りに対し、反射鏡の中心軸に合致させる位置調整が十分可能なように、大きな径となる円筒形状としてある。なお、挿通孔3に挿入する口金の円筒部の形状は、固着後しづらい構造とするために、横断面形状が六角形のような場合も同様の効果がある。

【0012】前記構成により、光源装置のコンパクト化を図るために、液晶プロジェクタの内部で使用される光源装置の周囲温度が高く設定されても、従来のように反射鏡の首状部内面の硝子加工部からクラックが発生することはなく、寿命特性が改善される。例えば、水平位置で使用される装置の場合、反射鏡の最も高温となる部分は、図1のHの個所であり、従来例は約 480°C 前後となり、硝子の歪み温度は 520°C であるにも係らず、点灯を繰り返すと削り加工した部分の周辺よりクラックし

てしまう。一方、本発明に係る反射鏡は、首状部の型押し部に削り加工した部分がなく、該部分が高温部とならないので、同一組成の硝子を用いても点灯時 500°C 前後の温度となっても、ランプ寿命期間中にクラックが生じることはない。

【0013】又、反射鏡とランプとを位置調整後、シリカ・アルミナを主成分と接着剤を用いて固着している。接着剤の注入口である反射鏡の首状部4の底部に設けた切り欠き部より接着剤21を注入するが、最狭部4bで接着剤が流出することを防止してあるので、接着剤が型押し部4aおよび反射面1aに流入することがなく、硝子製の反射鏡と接着剤との熱膨張差によって生じる応力によるクラックの発生も防止することができる。

【0014】

【発明の効果】以上説明したように、本発明に係る反射鏡付きショートアーク放電ランプは、反射鏡の底部の首状部の構造、形状を改良して、発熱源であるランプの発光部に近接する面は削り加工を施さない。このために、反射面に接するランプ挿通孔の端面を型押し面のままとし、かつランプのネジ付き口金を囲む挿通孔の周囲部は口金の円筒部と同形の円筒状部としている。そして、十分に径を大きくすることにより、反射鏡とランプとの光軸調整はランプの製造上のばらつきが生じていても、十分に行なえる。さらに、挿通孔の円筒状部と型押し部との間に仕切となる最狭部を設けることにより、作業中に接着剤が反射面側に流入することがなく、ランプ寿命中に高温になってもクラックが発生することはなく、光学的な効率が優れた反射鏡付きショートアーク放電ランプが得られる。

【図面の簡単な説明】

【図1】本発明に係る実施例の断面図である。

【図2】同じく、図1の要部拡大断面図である。

【図3】従来の反射器の型押し成形後の状態を示す説明図である。

【図4】同じく反射器の後加工状態を示す説明図である。

【図5】同じく反射器と電球のユニットを示す要部断面図である。

【符号の説明】

- | | |
|---------|--------------|
| 1 | 反射鏡 |
| 2 | 開口部 |
| 3 | 挿通孔 |
| 4 | 首状部 |
| 4a | 型押し部 |
| 4b | 最狭部 |
| 4c | 円筒状部 |
| 11 | ショートアーク放電ランプ |
| 12a、12b | 電極 |
| 13a、13b | モリブデン箔 |
| 14a、14b | 封着部 |

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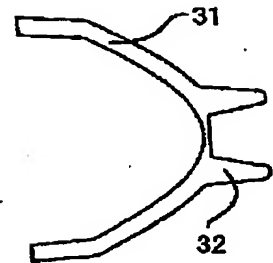
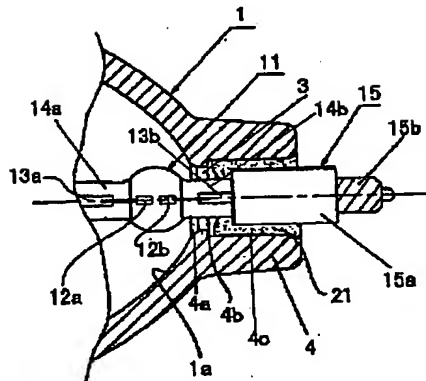
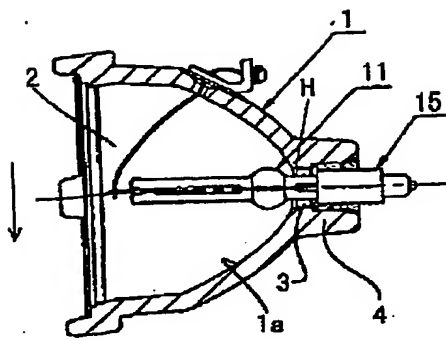
15 ネジ付き口金
15a 円筒部

15b ネジ部
21 接着剤

【図1】

【図2】

【図3】



【図4】

【図5】

